



Soil Biotechnology in Thailand

Introduction

Soil is the habitat of several types of microorganisms, both advantages and disadvantages. Useful soil microorganisms play important roles, related to the decomposition of organic matter, turnover or recycling and releasing nutrients that are beneficial to the soil. Moreover, they help to create a production of substances that promote plant growth, enabling the grain coagulation and stability, and pest control. These activities have influenced the growth of most plants.

Soil microorganisms are live in the soil. They play the role in nutrient cycling and soil fertility such as microbial decomposing organic matter, which produces extracellular enzymes degrading organic matter that enable to improve soil property. Some part of nutrients is released back into the plant. Basically, microbial conversion of inorganic compounds have a role in deforming minerals in the soil that is not in the useful form to be in the useful form for plants. Nitrogen-fixing bacteria are bacteria that can turn nitrogen in the air into a form of nitrogen compounds, which plants can use directly. Microbial can increase the efficiency in up taking of plant nutrients such as mycorrhiza fungi, will help plants uptake more nutrients especially phosphorus, which is an element that hardly moves in the soil. Microbial produce chemical enhancing plant growth and that of hormones as well as stimulating seed germination and root crops and accelerating plant growth promoted flowering and increased fruit. Microbial controlled plant pathogens are microorganisms that can create antibiotics and organic acids inhibiting the plant pathogen caused of plant disease or microorganisms that can produce enzymes such as kitinase, laminarinase to destroy cell wall of plant pathogen. Land Development Department has studied in soil microorganisms, involving total production for producing the products in order to use as the key factor in agricultural production. The product is known as Microbial Activator Super LDD. Microbial Activator Super LDD is used with the production of organic fertilizers with high nutrient content. It is called as High quality organic fertilizer, Land Development Department formula.



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Microbial product of Land development department

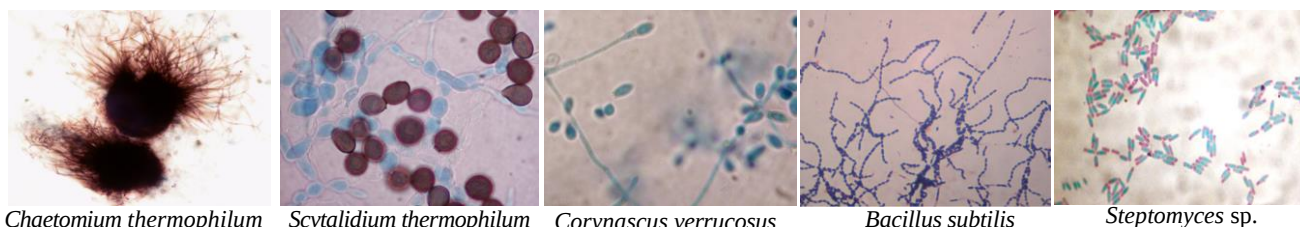
Currently, the Microbial product of Land development department are divided into 3 groups with 8 types of product. Those 3 groups are the microbial for soil improvement, increasing plant nutrient and plant growth hormone, the microbial for biocontrol and the microbial for environment.

1. Group of Microbial product for soil improvement, increasing plant nutrient and plant growth hormones. The microbial products are activator Super LDD 1 for compost production, Microbial activator Super LDD 2 for produce bio-extract, Microbial activator Super LDD 9 as phosphate solubilizing bacteria increasing available phosphate in acid and sulfate acid soil, Microbial product for green manure LDD 11 to increase biomass and plant nutrient for leguminosae green manure (*Sesbania rostrata* and *Crotalaria juncea* L.) and bio-fertilizer LDD 12 for increasing soil fertility and produce plant growth hormone to enhance plant growth.

1.1 Utilization of Microbial activator Super LDD 1 for compost production

Microbial activator Super LDD 1 is a group of high efficient microorganisms to decompose crop residue and agro-industry process which consist of hardly decompose component such as cellulose, lipid and lignin to decrease decomposition time for making the compost. Group of microorganisms in Microbial activator Super LDD 1 consist of Cellulolytic fungi:

Corynascus verrucosus, *Scytalidium thermophilum*, *Chaetomium thermophilum* and *Scopulariopsis brevicaulis*. Cellulolytic actinomycetes: 2 strains of *Streptomyces* and Lipid degrading bacteria: 2 strain of *Bacillus subtilis*.



Chaetomium thermophilum

Scytalidium thermophilum

Corynascus verrucosus

Bacillus subtilis

Streptomyces sp.

As the crop residues and dung were brought to ferment prior to be used, the heat generated during the decomposition process accumulated in the compost pile to break some kind of plant pathogens such as *Helminthosporium maydis* that caused leaf blight of corn, *Curvularia lunata* causing leaf spot of corn and *Collectotrichum dermatium* var. *truncatum* causing





Anthrax disease of soybean. Including the destruction of parasite eggs and bacteria that cause diseases like typhoid causing bacteria as *Salmonella typhosa*, *Shigella* sp. causing dysentery, and *Mycobacterium tuberculosis* that causes tuberculosis in lung etc.

1) Raw material proportion and composting procedure

Raw material proportion component of making compost 1 ton

- Plant residue)dry weight(1000, kg
- Animal manure 200 kg
- Urea 2 kg or bio-extract from fish 9 liters
- Microbial Activator Super LDD 1 1 package (100 g)

2) Composting procedure



1) 1 ton of compost heap is width x length x height = 2 x 3 x 1.5 meters.



2) Mixing microbial activator Super LDD1 in 20 liters of water and stir for 10-15 minutes.



3) The material separate to 3 layers, the first layer is spread plant residue as the base of pile has width range 2 meters, 3 meters of length with of first layer 50 cm. Watering waste evenly as each layer is completed.



4) Top with animal manure and spread out into an even layer.





5) Dressing with urea or bio-extract from fish on animal manure layer.



6) Distribute microbial suspension over the compost pile which finish the first layer. Procedure these steps as the second and third layer.



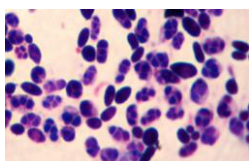
7) Top of heap are covered with a layer of soil / plastic/ coconut leaves to help retain moisture content. Layer.

3) Application rate of compost

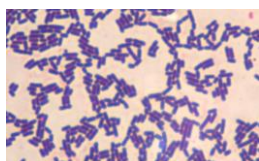
Rice:	12.5 ton/ha, broadcast throughout planting area.
Field crop:	12.5 ton/ha, banding along the row of plant.
Vegetable:	25 ton/ha, broadcast throughout planting area.
Fruit tree:	20- 50 kg/plant, placement compost into the groove and cover with soil.
Flowering plant:	cut flower plant use 12.5 ton/ha and flowering tree use 5-10 kg/plant

1.2 Utilization of Microbial activator Super LDD 2 for produce bio-extract

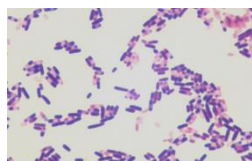
Microbial activator Super LDD 2 is a group of high efficient microorganisms which can activate fermentation and digestion process of organic waste such as fresh and succulent from fruit, vegetable, fish and snail by effective microorganisms in anaerobic and facultative anaerobic condition. The components of bio-extract are plant growth hormones (auxin, gibberillin, cytokinin), amino acid, humic acid, organic acid, vitamin and minerals. They consist to 5 stains of microorganisms:



Pichia membranifaciens



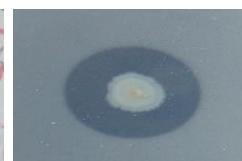
Lactobacillus fermentum



Bacillus megaterium



Bacillus subtilis



Burkholderia unamae





1) Raw materials to produce bio-extract

1.1) Formula of bio-extract from fruit and vegetable

(Fermentation time: 7 days)



Fresh and succulent of fruit or vegetable residue 40 kg.



Molasses 10 kg, water 10 liters.



Microbial activator Super LDD 2 1 package (25g).

1.2) Formula of bio-extract from fish and snail

(Fermentation time: 15-20 days)



Fresh and succulent of fish, snail 30 kg



Fresh and succulent of fruit residue (pine apple) 10 kg



Molasses 10 kg, water 10 liters



Microbial activator Super LDD 2 1 package (25g)

2) Step to produce bio-extract



1) Mix molasses with water thoroughly in the mixing tank.



2) Suspend microbial activator Super LDD 2 1 pack in molasses or other sugar solution and stir continuously for 5 minutes.





3) Pour raw material, witch chop into small pieces in mixing tank.



4) And mix together.



5) Close a cover and put the tank under shady area, stir these substances every day.

3) Consideration of completely fermentation process

- Reduction of microbial growth.
- Reduction of CO₂ bubble.
- Reduction of alcoholic smell.
- Dropping of sour smell.
- Dropping of pH down to 3-4.

4) Utilization and application rate of bio-extract

4.1) Rice

- Soaking seed: mix bio-extract 2 tablespoons in water 20 liters, soaking seed for 12 hrs, taken up 1 day and then broadcast.
- Incorporation of rice stubble: mix bio-extract 31.25 liters in water 625 liters, pour throughout planting area 1 ha and ferment 15-10days.
- During growth stage: mix bio-extract 12 tablespoons in water 60 liters, spray at 30, 50 and 60 day during growing stage.

4.2) Field crop: mix bio-extract 3.75 liters in water 1,250 liters spray every 10 days before flowering stage in area 1 ha.

4.3) Vegetable and flower: mix bio-extract 37.5 tablespoons in water 625 liters spray every 10 days in area 1 ha.

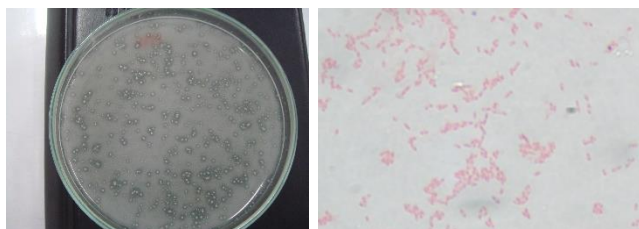
4.4) Fruit tree: mix bio-extract 20 tablespoons in water 100 liters spray every 1 month before flowering stage.





1.3 Increasing available phosphate for in acid soil and acid sulfate soil by Microbial Super LDD 9

Microbial Super LDD 9 is phosphate solubilizing bacteria, capable of dissolve phosphorus from insoluble compounds to available form in acid soil and acid sulfate soil (pH less than 4). They consist of 2 bacteria strains: *Burkholderia* sp.



Burkholderia sp.



1) Raw material to Microbial Super LDD 9 cultivation



Compost 300kg



Rice bran 3 kg



Microbial Super LDD 9
1 package

2) Procedure to cultivate



2.1) Mix compost with rice bran



2.2) Suspend microbial activator Super LDD 9 in water, stir continuously for 5 minutes.



2.3) And pour solution microbial Super LDD 9 into material mixed.



2.4) Mix together and maintain moisture content approximately 70%.



2.5) Such materials are piled as rectangular



2.6) Top of pile is covered and maintains





3) Utilization and application rate of Microbial Super LDD 9

- Rice, field crop, vegetable and ornamental plant t: 625 kg/ha, broadcast throughout planting area or banding along the row of plant.
- Fruit tree: 3 kg/plant, placement into the hole and cover with soil or application around the bush.
- Seedling plot: 1 kg/10 m², broadcast throughout planting area.

1.4 Microbial for green manure LDD 11

Microbial for green manure LDD 11 is a group of co inoculation between nitrogen fixing bacteria (Rhizobium) and phosphate solubilizing bacteria produce organic acid to dissolve inorganic phosphorus complex to available from: *Burkholderia* sp. for increase biomass and nutrient content of leguminosae green manure (*Sesbania rostrata* and *Crotalaria juncea*).



Rhizobium



Phosphate solubilizing bacteria

1) Raw material to microbial activator for green manure LDD 11 cultivation

Compost	100	kg
Rice bran	1	kg
Microbial activator LDD 11	1	package (100 g)





2) Procedure to cultivate



2.1) Mixing microbial activator for green manure in LDD 11 and rice bran in water 5 liters, then 5 minutes stirring.



2.2) Pour suspends solution of microbial activator for green manure in LDD 11 into compost pile and mix together. Such materials are piled in rectangular with 50 cm height under shady area. Top of pile are covered and moisture content about 60-70 % throughout 4 days.

3) Application rate of LDD 11 cultivation (*Sesbania rostrata* and

Crotalaria juncea)

- Broadcasting throughout planting area banding along the row of plant 625 kg/ha.
- Broadcasting of *Crotalaria juncea* Seeding rate 31.25 kg/ha.
- Seed of *Sesbania rostrata* were soaked in running tap water overnight to break down seed dormancy. Broadcasting seeding rate 31.25 kg/ha.

4) Advantage

4.1) Increase nitrogen in the soil, moreover it can be nitrogen source in organic agriculture system. Increase fresh weight, dry weight of African Doncha and Sunhemp.

4.2) Increase organic matter, soil fertility, improve physical and chemical including biological properties of soil.

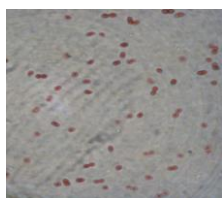
4.3) Increase economic crop yield.



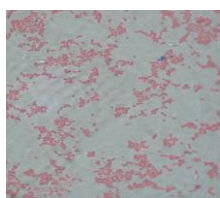


1.5 Bio-fertilizer LDD 12 to increase soil fertility and produce plant growth hormone

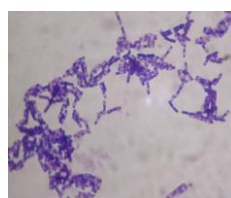
Bio-fertilizer LDD 12 is a group of effective microorganisms that can produce nutrient element or convert insoluble of inorganic compounds into soluble form to increase soil fertility and produce plant growth hormone to enhance plant growth hormone to enhance plant growth. They consist of 4 kind of microorganisms namely Free-living nitrogen fixing bacteria (*Azotobacter tropicalis*), Phosphate solubilizing bacteria (*Burkholderia unamae*), Potassium solubilizing bacteria (*Bacillus subtilis*) and Plant growth promoting rhizobacteria or plant hormones)*Azotobacter chroococcum*(.



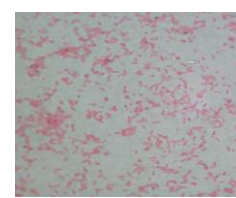
Azotobacter tropicalis



Burkholderia unamae



Bacillus subtilis



Azotobacter chroococcum

1) Raw material to biofertilizer LDD 12 cultivation

Compost	300	kg
Rice bran	3	kg
Biofertilizer LDD 12	1	package 100) g (
Cultivation time	4	days

2) Procedure to cultivate



2.1) Mixing biofertilizer LDD12 and rice bran in water 20 liters.





2.2) Pour solution of biofertilizer LDD 12 into compost and mix together.



2.3) Such materials are piled as rectangle with 50 cm height under shading area. Top of pile is covered and maintained moisture to 60-70% throughout 4 days.

3) Utilization and application rate of biofertilizer LDD 12 culture with chemical fertilizer for planting.

Kind of plant	Application rate		How to use
	Biofertilizer LDD 12	Chemical fertilizer	
rice			
1. Non- photoperiod-sensitive phase	1,875 kg/ha	16-20-0, 126.5 kg/ha	Broadcasting throughout planting area.
2. photoperiod-sensitive rice	1,875 kg/ha	46-0-0, 6.25 kg/ha 16-16-8, 118.75 kg/ha 46-0-0, 50 kg/ha	
Field crop			
.1maize	1,875 kg/ha	15-15-15, 237.5 kg/ha	Banding along the row. New planting: Broadcasting throughout planting area. Plant growth period: Banding along the row. Banding along the row.
.2Sugarcane	1,875 kg/ha	46-0-0, 50 kg/ha 15-15-15, 375 kg/ha	
.3Cassava	1,875 kg/ha	15-7-18, 187.5 kg/ha)separate for 2 times(	
Vegetable	1,875 kg/ha	15-15-15, 143.75 kg/ha 46-0-0, 50 kg/ha	Broadcasting throughout planting area banding along the row.
Oil palm tree	5kg/plant/time 3)times/year(	0-0-21,5. 5 kg/plant/3 years 0-46-18, 1.7kg/plant/3 years 4.9 ,60-0-0kg/plant/3 years	Prepare planting holes: placement into the hole and cover with soil. Plant growth period: Application around the bush
lubber tree	5kg/plant/time)2 times/year(	New planting lubber tree: 20-8-20, 1.13-1.88 kg/plant/year)separate for 4 times(Cutting rubber tree: 30-11-22, 4.69 kg/plant/year (4 Times)	Application around the bush

Note: Application rate of chemical fertilizer as decrease 25 % of recommend rate



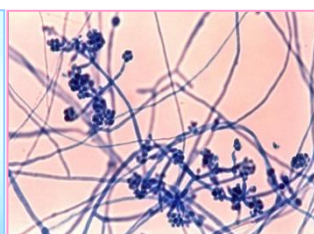
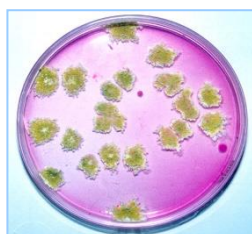


2. Group of microbial for biocontrol

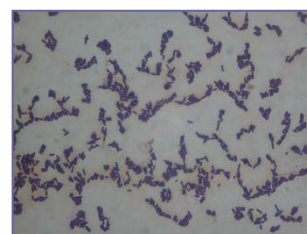
Group of microbial for biocontrol is microbial activator Super LDD 3 antagonistic microorganisms control plant pathogen and microbial activator Super LDD 7 for insect pest repellent production.

2.1 Antagonistic microorganisms by microbial activator Super LDD 3

Group of the antagonistic microorganisms which can control and inhibit soil born plant pathogens both upland and lowland area especially, roots rot disease of economic crops. They consist of *Trichoderma* sp. and *Bacillus* sp.



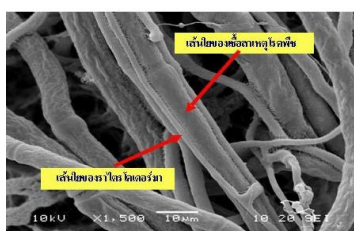
Trichoderma sp.



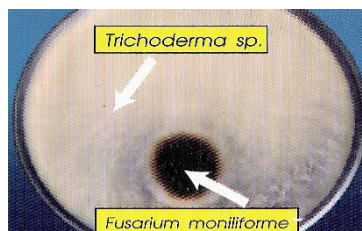
Bacillus sp.

1) Antagonistic mechanism

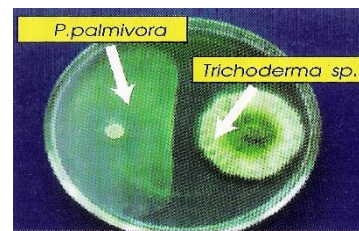
- Ability of nutrient competition and grower than plant pathogen. It is important for limiting disease incidence and severance.
- Directly destruction the hyphae of plant pathogen by producing lytic enzyme to break cell and uptake protoplasm within hyphae as nutrient source.
- Excretion of antibiotic and toxic substance to inhibit plant pathogen. Antibiotic is microbial toxins which can poison or kill other microorganism and most microbes produce more compounds with antibiotic activity.



Directly destruction plant pathogen



Ability of nutrient competition



Excretion of antibiotic





2) Raw material to microbial activator Super LDD 3 cultivation

Compost	100	kg
Rice bran	1	kg (or chicken manual, bat manual)
Microbial activator Super LDD 3	1	package (25g)

3) Procedure to cultivate



3.1) Mixing microbial activator Super LDD 3 and rice bran in water 5 liters, 5 minutes stirring.



3.2) Pour solution of Super LDD 3 into those materials and mix together.



3.3) Such materials are piled as rectangle with 50 cm height under shading area. Top of pile is covered and maintained moisture to 60-70% throughout 7 days.

3.4) Antagonistic mechanism population of microbial Super LDD3 are increased by observing white hyphae and green color of Trichoderma spore .mix together and keep under shading area.

4) Utilization and application rate

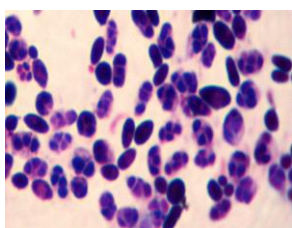
- Rice, field crop, vegetable and and ornamental plant: 625 kg/ha, broadcast throughout planting area or banding along the row of plant.
- Fruit tree: 3-6 kg/plant, placement into the hole and cover with soil or application around the bush.
- Seedling plot: 1-2 kg/10 m², broadcast throughout planting area.





2.2 Insect pest control substance produce by microbial activator Super LDD 7

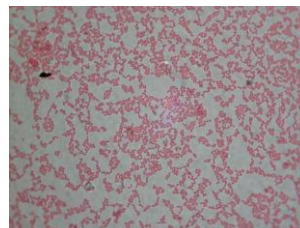
Microbial activator Super LDD 7 is a group of microorganisms which can active the process of fermentation and digestion of herbs for producing insect active ingredient. They consist yeast (*Saccharomyces* sp.), acetic acid bacteria (*Gluconobacter oxydans*) and lactic acid bacteria (*Lactobacillus fermentum*).



Saccharomyces sp.



Gluconobacter oxydans



Lactobacillus fermentum

Biological extracts produced from fermented herbs by activity of microorganisms contains active ingredients, insect repellants and high amount of several kind of organic acids.

1) Kind of herb for insect pest control

Herb for insect pest control: mealybug and aphids				
				
Tobacco	Long pepper	Derris	Asiatic bitter yam	Chili

Herb for insect pest control: common cutworm and short-hole worm				
				
Sweet flag rhizomes	Yam bean seed	Neem seed	Non Taai Yaak rhizomes	Curcuma rhizomes





2) Raw material to produce insect pest control substance by microbial activator

Super LDD 7

Fermentation of fresh herb

Herbs	30	kg
Molasses or other sugar	10	kg
Rice bran	100	g
Water	30	liters
Microbial activator Super LDD 7	1	package (25g)

Fermentation of dry herb

Herbs	10	kg
Molasses or other sugar	20	kg
Rice bran	100	g
Water	60	liters
Microbial activator Super LDD 7	1	package (25g)

3) Step to produce insect pest control substance



3.1) Chop or pound each type of herbs into small pieces



3.4) Pour suspension into mixing tank and mix together.





3.2) Mix ground herb with rice bran thoroughly in mixing tank



3.5) Close a cover and put the tank under shady area, stir these substances every day, fermentation time 21 days.



3.3) Suspend Molasses or other sugar in water, pour microbial activator Super LDD 7, 5 minutes stirring.

4) Consideration of completely fermentation process

- Reduction of microbial growth.
- Reduction of CO₂ bubble.
- Reduction of alcoholic smell.
- Dropping of sour smell.
- Dropping of pH down to 3-4.

5) Utilization and application rate of insect pest control from microbial activator

Super LDD 7

- Dilute with water 1:100, spray every 3-5 days and spray continues 3 times in spread period of insect pest.
- Mix surfactant such as dishwasher 10 ml into insect pest control from microbial activator Super LDD 7 10 liters.
- Field crop Vegetable and flower: spray 313 liters in area 1 ha.
- Fruit tree: spray 625 liters in area 1 ha, leaf stem or insect.





3. Group of microbial for environment

Group of microbial for environment is microbial activator Super LDD 6 for waste water treatment, reduced odorous and controlling *Culex* mosquito larvae population.

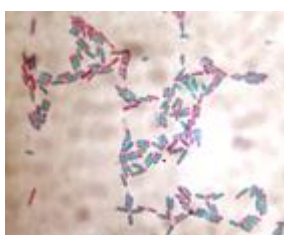
Microbial activator LDD 6 is a group of high efficient microorganisms which can activate fermentation and digestion process of kitchen waste such as residues from fruit, vegetable, fish and lipid from food and has bacteria control larva of urban mosquito for producing waste water treatment, reduced odorous, clean animal housing and control larva of *Culex* mosquito substance, which consist to yeast (*Saccharomyces cereviceae*.), lactic acid bacteria (*Lactobacillus fermentum*), proteolytic bacteria (*Bacillus cereus*), lipolytic bacteria (*Bacillus subtilis*) and mosquitocidal bacterial toxins (*Bacillus sphaericus*)



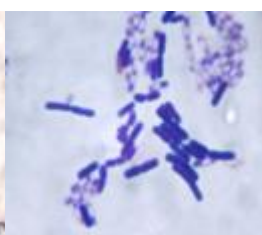
Saccharomyces cereviceae



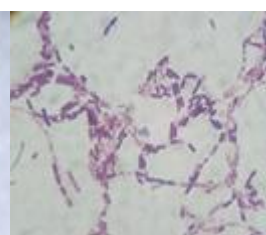
Lactobacillus fermentum



Bacillus cereus



Bacillus subtilis



Bacillus sphaericus

1) Production waste water treatment and reduced odorous substance from kitchen wastes

1.1) Raw materials to produce waste water treatment and reduced odorous substance 50 liters

Kitchen wastes	40	kg
Molasses	20-10	kg
Water	10	liters
Microbial activator Super LDD 6	1	package (25g)





1.2) Step to produce waste water treatment and reduced odorous substance



1. Mix molasses or granulate sugar with water thoroughly in the mixing tank.



2. Suspend microbial activator Super LDD 6 1 pack in molasses or granulate sugar solution.



3. Stir continuously for 5 minutes.



4. Pour raw material into mixing tank and mix together.



5. Close a cover and put the tank under shady area, stir these substances every 2-3 days, fermentation time 20 days.

2) Production waste water treatment and reduced odorous substance by cultivation of microbial activator Super LDD 6

2.1) Raw material for cultivation

Molasses	5	kg
Water	50	liters
Microbial activator Super LDD 6	1	package (25g)

2.2) Procedure to cultivate



1. Mix molasses or granulate sugar with water thoroughly in the mixing tank.
2. Suspend microbial activator Super LDD 6 1 pack in molasses and stir continuously for 5 minutes.
3. Close a cover and put the tank under shady area, cultivation time 4 days and use rapidly.





3) Utilization bacteria in microbial activator Super LDD 6 for controlling Culex Mosquito larva population

- Culex Mosquitos are vector for Japanese Encephalitis and Bancroftian Filariasis which habitat in waste water.

- *Bacillus sphaericus* produce specifically toxins with various mosquito types, mosquito larva. *B. sphaericus* are brought into gut of mosquito larva by eating. Base condition in the gut change crystal toxin of *B. sphaericus* from inactivated to activated form. The activated form toxins make gut wound, blood poisoning and finally the larva die.

4) Utilization and application rate for waste water treatment and reduced odorous

4.1) Waste water treatment and use in Aquatic farms: use waste water treatment reduced odorous and control of urban mosquito larva substance 1 liter per water 10 m³, every 10 days.



4.2) Clean animal housing : dilute waste water treatment reduced odorous and control of urban mosquito larva substance with water 1 : 10, spray throughout treat area every day or every 3 days.



4.3) Utilization and application rate for controlling urban mosquito larva population : Strew microbial activator Super LDD 6 1 package (25g) throughout treat area 10m² and touch to urban mosquito larva.

